STUDY OF TIME LAPSE PROCESSING FOR DYNAMIC HYDROLOGIC CONDITIONS

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26 April 1973
Type II Progress Report for
Period 6 September 1972 - 6 March 1973

Prepared for
Goddard Space Flight Center
Greenbelt, Maryland 20771

TYPE II PROGRESS REPORT

A) Title: STUDY OF TIME LAPSE DATA PROCESSING FOR DYNAMIC HYDROLOGIC CONDITIONS

ERTS-A PROPOSAL 342-B

B) GSFC ID PR154

C) Previous and Current Activities

1 - Hardware

The past 6 months has seen us complete all the electronic modifications to the ESIAC to meet the basic data processing requirements of the participating investigators in the U.S.G.S. (WRD) program in Dynamic Hydrology.

The physical set up of the main console and its auxiliary displays comprising the ESIAC system has been described and illustrated in the Type I reports of November 6, 1972 and January 6, 1973. Figure I is a block diagram of the ESIAC as it will appear when the binary memory mask (scratchpad memory) is completed. This semiconductor memory will serve for storing and editing binary thematic image masks and provide the capability for simultaneous time lapsed color imagery and area measurements of this imagery. These aspects of the system were also discussed in the previous progress reports. Design specifications for this capability have been completed and both vendor and in-house costs are being reviewed for the construction of this subsystem.

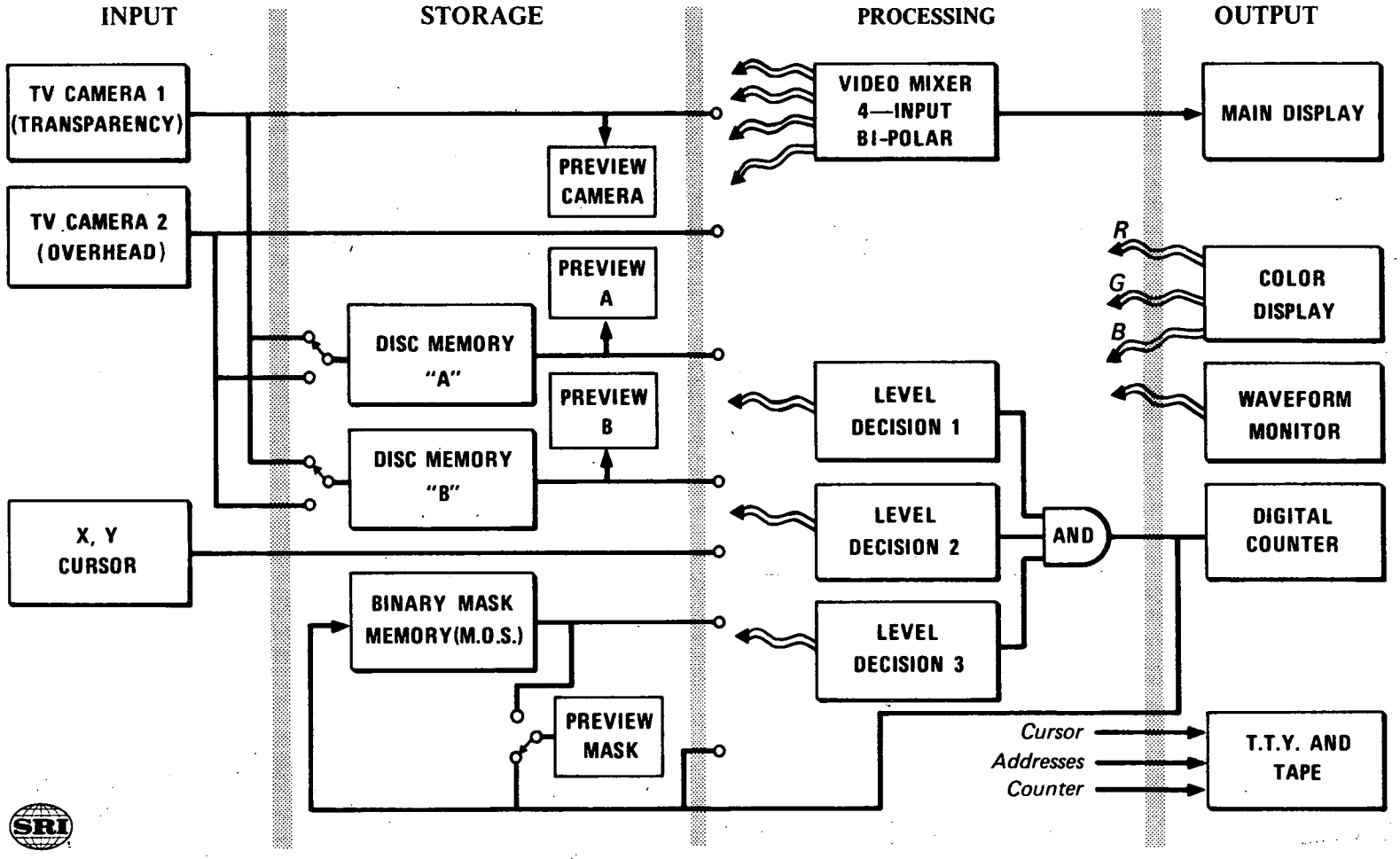

FIGURE 1 BLOCK DIAGRAM OF ESIAC

The color display which was added on an experimental basis to explore the use of time lapsed color for enhancement is now a permanent feature of the system. Presentation (e.g., of MSS band 5 and 6) in a two color display has proved to be a very effective method for resolving ambiguities between snow and bright, healthy vegetation. Investigators have invariably looked first at the color display whenever it was provided although they then want to check individual bands in monochrome.

The three video level-decision circuits shown in Fig. 1 are each a fast one bit analog-to-digital converter having an adjustable threshold level. For example, in use, decision Circuit No. 1 might be connected to the output of disc channel A, and adjusted to respond only during those portions of its image which exceed some chosen threshold value--say, all snow and clouds which are brighter than the selected threshold. Decision Circuit No. 2 might be arranged to respond to only the very darkest portions of the image from one of the cameras, which might be viewing a registered map having a specified geographic area blacked in. Thus, by combining the outputs of the two binary decision circuits in a logical AND circuit a two-level video signal is synthesized which is high (TRUE) only during very white areas that are also within some specified geographic boundary. The binary video signal can be displayed as an image, photographed, stored, superimposed onto other images, or the total number of TRUE picture elements in the frame can be counted by the digital counter.

2 - Data Processing

We are continuing to obtain snowfield measurements in specific drainage areas in the north cascade range in north central Washington for Dr. Meier (IN045) of the U.S.G.S. Water Resources Division in Tacoma, Washington. For Mr. Fred Ruggles (IN395) at the U.S.G.S. Water Resources Division in Hartford, Connecticut, the ESIAC is being used to enhance the visibility of patterns caused by the suspended sediments in the waters of the Connecticut, Thames, and Housatonic Rivers, to study the mixing patterns of estuarine discharges into Long Island Sound at different phases of the tidal cycle.

The same image enhancement techniques are being applied to the ERTS-1 imagery of large turbidity plumes generated by the Niagra, Gennesee and Oswego Rivers. This imagery reveals the movement of these river borne sediments into as well as in Lake Ontario. This work is being done for Mr. E. J. Pluhowski (IN058) U.S.G.S. (WRD) Arlington, Virginia. Dr. Pluhowski now has enough E.R.T.S. sequences to begin to exploit the trend enhancing power of time lapse viewing of this imagery. The available time lapse sequence, for example, showed the strong dependence of plume distributions upon wind direction and speed in the lake.

It is interesting to note that for snowfield measurements best results are obtained using 70 mm viewing positives, combining MSS bands 5 and 6 in a two color display. However to enhance

the visibility patterns caused by suspended sediments in rivers and lakes, it is better to use 70 mm negatives. Sediments suspended in water increase the reflectivity slightly and act as tracers. Thus river discharge plumes are visible from space as subtle modulations of the sediment patterns. For this work, the interest is almost entirely at the lowest end of the radiance scale, and best results have been obtained by working from negative transparencies inverting them to positive images electronically when required and using the entire brightness gamut of the video system to enhance only the first two or three steps of the gray range.

Data processing is continuing for Dr. Raymond M. Turner (IN411) of the U.S.G.S., WRD in Tucson, Arizona. He is studying the distribution of phreatophytes and other arid-land plant communities. For him, the equipment is being used as a versatile color micro-densitometer to prepare radiance profiles along specific transects and for radiance differences between spectral bands. Ultimately these profiles will be studied in time lapse along the imagery.

For a project of Dr. C. G. Reeves, Jr., (UN168) of Texas Technical University ("Dynamics of Playa Lakes in the Texas High Plains"), we are using the area-measuring capability to compile statistics on water areas within specific playas and totals for the hundreds of others within an ERTS frame (e.g., for the E.R.T.S. Frame 1078-16524-7 for 9 October 1972;

we counted 6631 playas). Additionally time lapse sequences will be searched for patterns in lake-fill distribution that might correlate with geographical, meteorological or seasonal conditions.

To date all but one of the participating investigators have been able to come to SRI for a "hands on" demonstration of the data handling, processing and documentation capabilities of the ESIAC relevant to their particular requirements. Data reduction and documentation requirements were established for routine data handling for the E.R.T.S. images to be processed for each of the investigators under the terms of the existing contract.

The data handling plans will be submitted for approval to the NASA Technical Contract Monitor by each of the investigators.

3 - Other Activities

A paper was prepared for presentation at the NASA ERTS-1 Symposium, March 5-9, 1973. The title and abstract are given below.

ANALYSIS OF ERTS IMAGERY USING SPECIAL ELECTRONIC VIEWING/MEASURING EQUIPMENT

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ABSTRACT

An Electronic Satellite Image Analysis Console (ESIAC) is being employed to process imagery for use by USGS investigators in several different disciplines studying dynamic hydrologic conditions.

The ESIAC provides facilities for storing registered image sequences in a magnetic video disc memory for subsequent recall, enhancement, and animated display in monochrome or color. Quantitative measurements of distances, areas, and brightness profiles can be extracted digitally under operator supervision. Initial results are presented for the display and measurement of snowfield extent, glacier development, sediment plumes from estuary discharge, playa inventory, phreatophyte and other vegetative changes.

At this symposium a specially prepared color movie was presented using a series of ERTS-1 frames to depict the changes with time of areal coverage of snow as well as changing coverage and color of vegetation and crops. A copy of this movie was left with the Government Technical Officer for this contract (Mr. A. H. Fihelly, Code 430). With the permission of the technical officer another copy was left with Mr. Morris Deutsch Research Coordinator, Water Resources E.R.O.S. Program, U.S. Geological Survey.

Both Mr. Serebreny and Mr. Evans attended the symposium.

D) Future Plans

1 - Hardware

It is planned to complete the construction of the scratchpad memory. Efforts will also continue to improve the geometric linearity of the vidicon camera in order to reduce errors in the area measuring capability. Near the corners of the picture, these errors have been found to be appreciably larger than originally expected.

Another modification in progress may be completed to permit recording the gray scale and annotation block during the vertical retrace interval for zoom views where this information ordinarily would

be lost. This will expedite making radiometric calibrations on data reproduced from the disc memories.

2 - Data Processing

To continue specified data processing for all the investigators as they forward new data. Mr. E. F. Hollyday (IN-389) will make an initial visit to S.R.I. early in April. Dr's Turner, Reeves, and Meiers plan to visit S.R.I. again during the next period. Hopefully enough imagery will be available to the investigators to employ the time lapse capability of the system:

a) to portray significant changes in the imagery parameters of interest to the individual investigators

b) to obtain quantitative measurements of these changes

c) to identify how these changes could relate to those occurring in atmospheric parameters reflected or implied in the E.R.T.S. imagery.